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Jung et al.

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(54) **LIGHT EMITTING DEVICE**

(71) Applicant: **LG INNOTEK CO., LTD.**, Seoul (KR)

(72) Inventors: **Se Yeon Jung**, Seoul (KR); **Yong Gyeong Lee**, Seoul (KR)

(73) Assignee: **LG INNOTEK CO., LTD.**, Seoul (KR)

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(51) **Int. Cl.**

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H01L 33/46	(2010.01)
H01L 33/06	(2010.01)
H01L 33/14	(2010.01)
H01L 33/62	(2010.01)

(52) **U.S. Cl.**

CPC ***H01L 33/382*** (2013.01); ***H01L 33/06*** (2013.01); ***H01L 33/145*** (2013.01); ***H01L 33/46*** (2013.01); ***H01L 33/62*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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Primary Examiner — Joseph Schoenholtz
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Disclosed is a light emitting device which includes a light emitting structure including a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer, a first current blocking layer, a second current blocking layer arranged on the light emitting structure to be separated from each other, a light-transmitting conductive layer arranged on the first current blocking layer, the second current blocking layer and the light emitting structure, first electrode and second electrode electrically coupled to the first conductive semiconductor layer and the second conductive semiconductor layer, respectively, a through hole formed through the light-transmitting conductive layer, the second conductive semiconductor layer and the active layer to a portion of the first conductive semiconductor layer, and a through electrode arranged inside the through hole. Here, the through electrode does not overlap the first current blocking layer in a vertical direction.

20 Claims, 18 Drawing Sheets

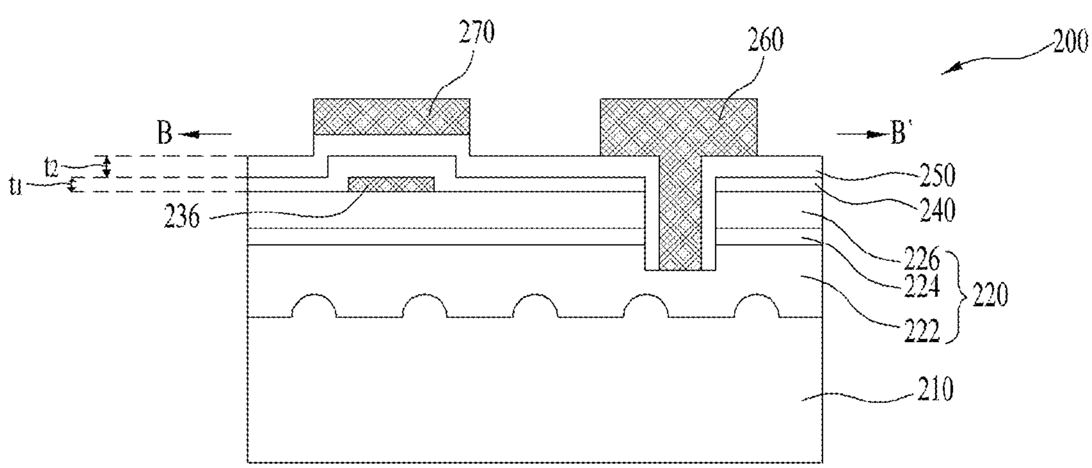


Fig. 1

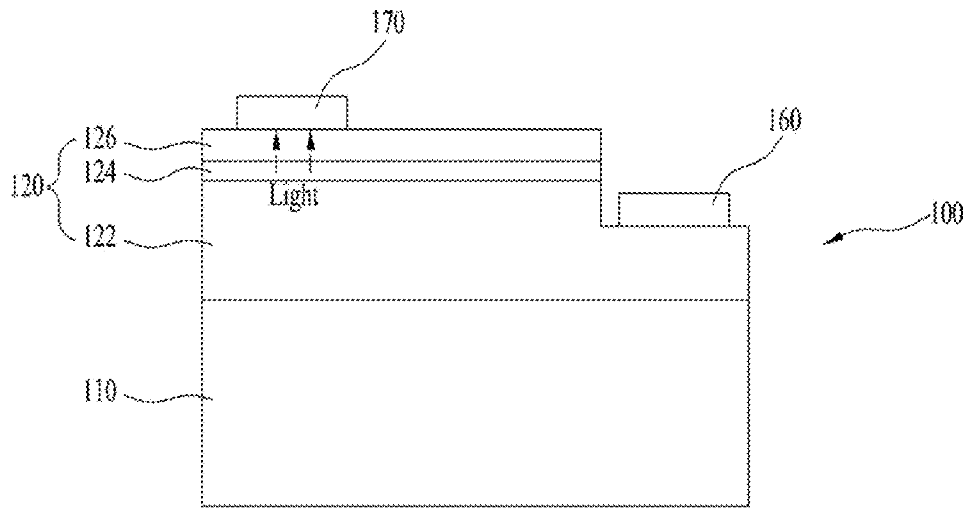

170
160
126
124
120
Light
122
100
110

Fig. 2a

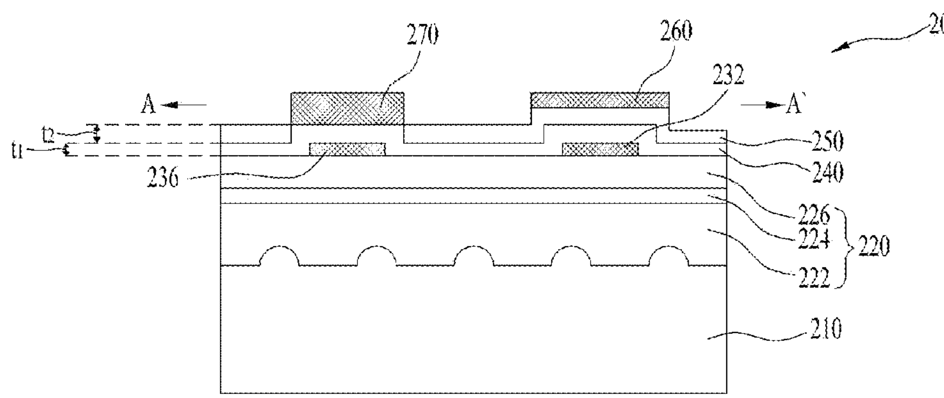
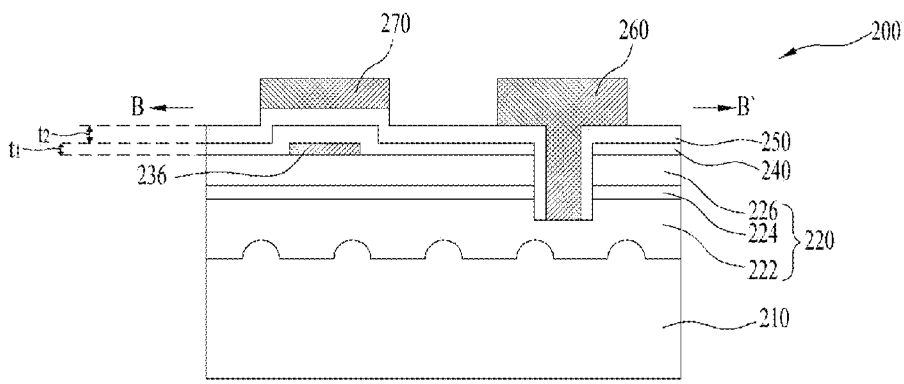
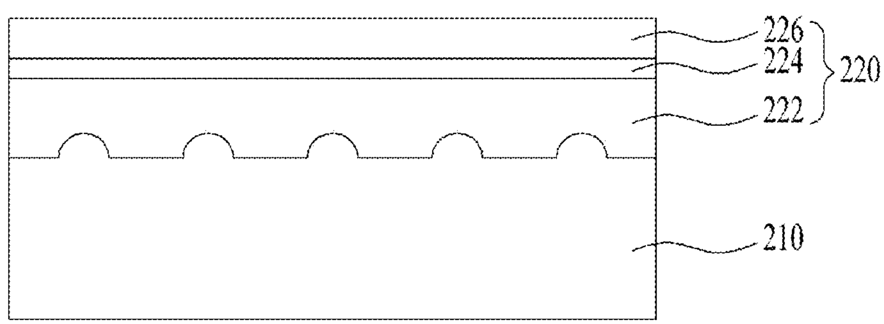

270
260
200
232
A
A`
t2
t1
250
240
236
226
224
220
222
210

Fig. 2b



270
260
200
B
B`
t2
t1
236
250
240
226
224
220
222
210

Fig. 3a



226
224
220
222
210

Fig. 3b

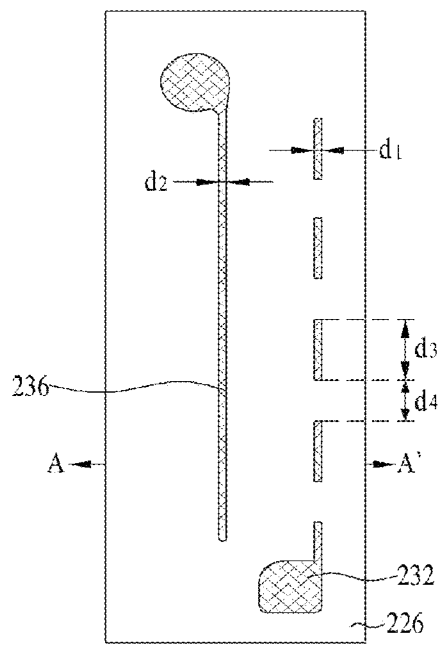


Fig. 3c

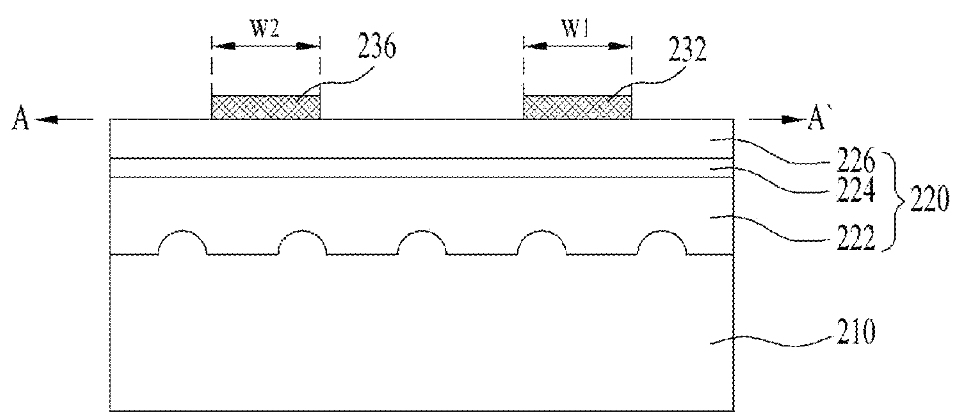


Fig. 3d

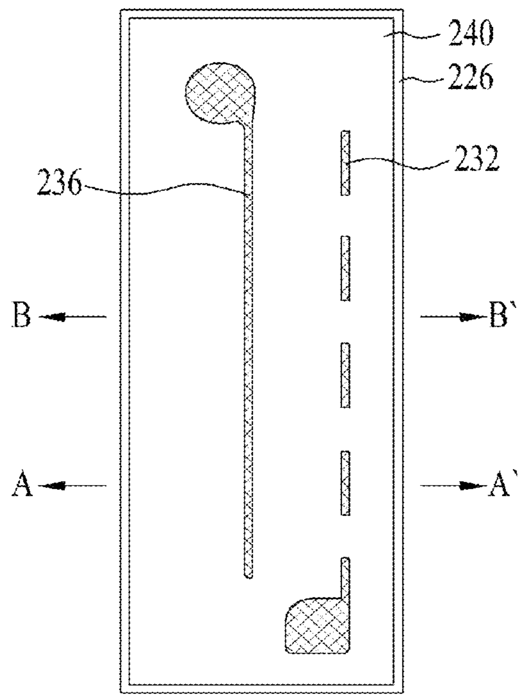


Fig. 3e

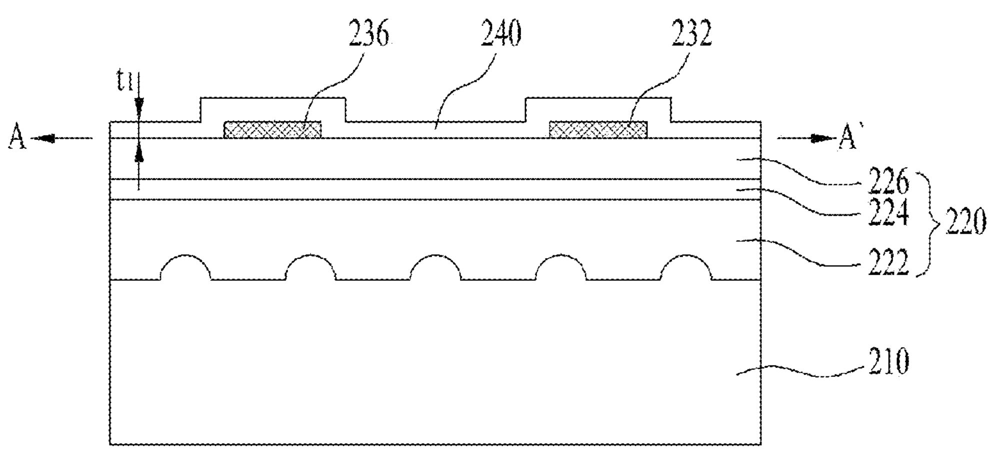


Fig. 3f

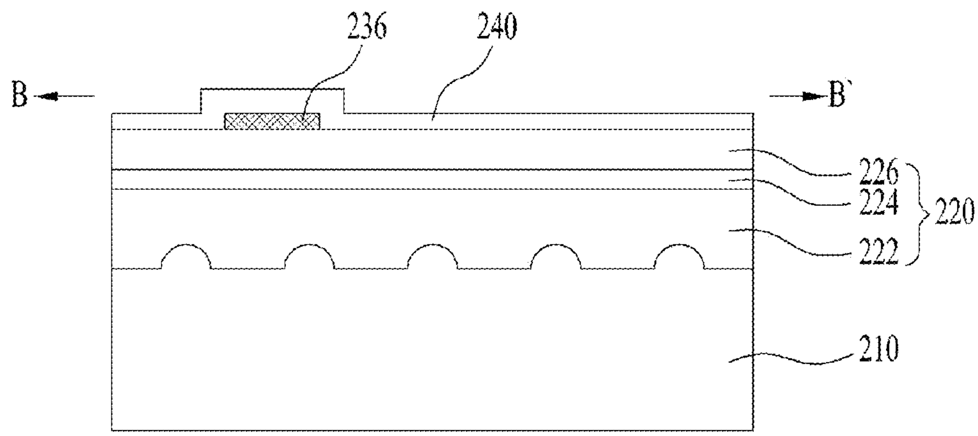

236
240
B
B`
226
224
220
222
210

Fig. 3g

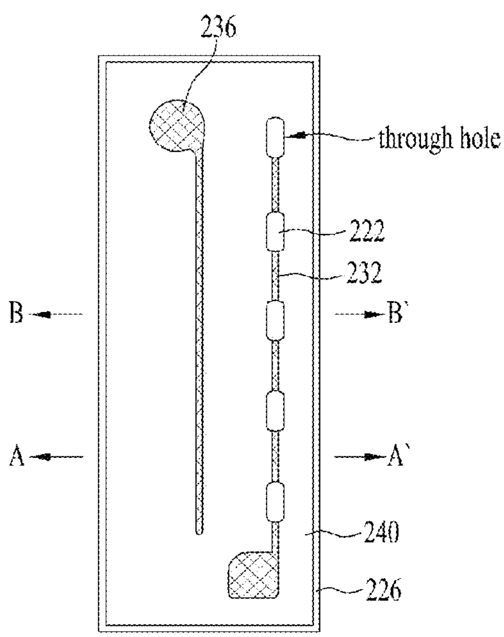

236
through hole
222
232
B
B`
A
A`
240
226

Fig. 3h

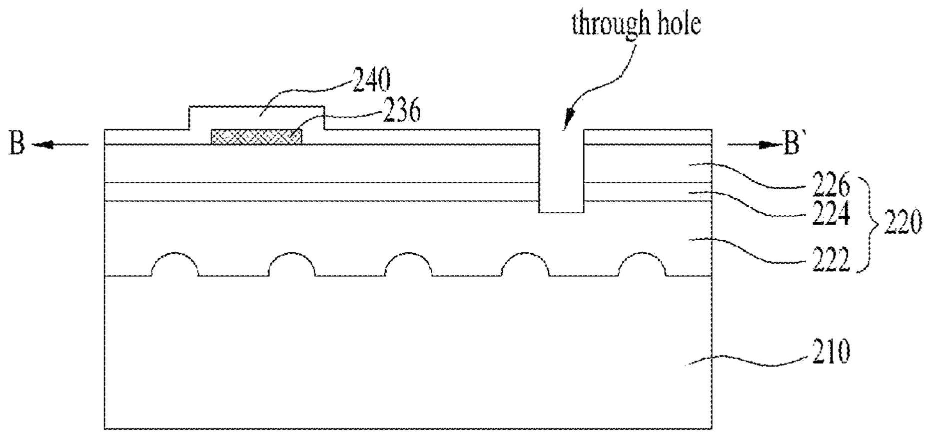

through hole
240
236
B
B`
226
224
220
222
210

Fig. 3i

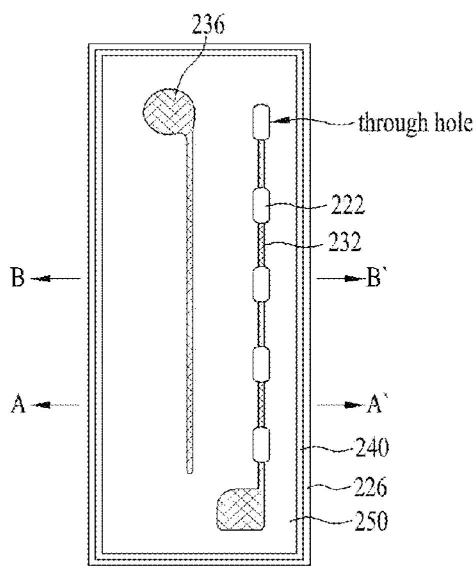

236
through hole
222
232
B
B`
A
A`
240
226
250

Fig. 3j

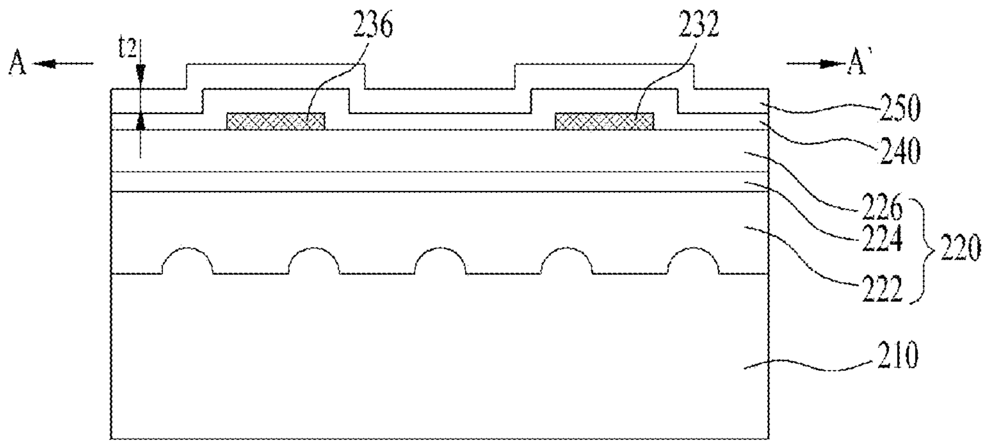

236
232
A
A'
t2
250
240
226
224
220
222
210

Fig. 3k

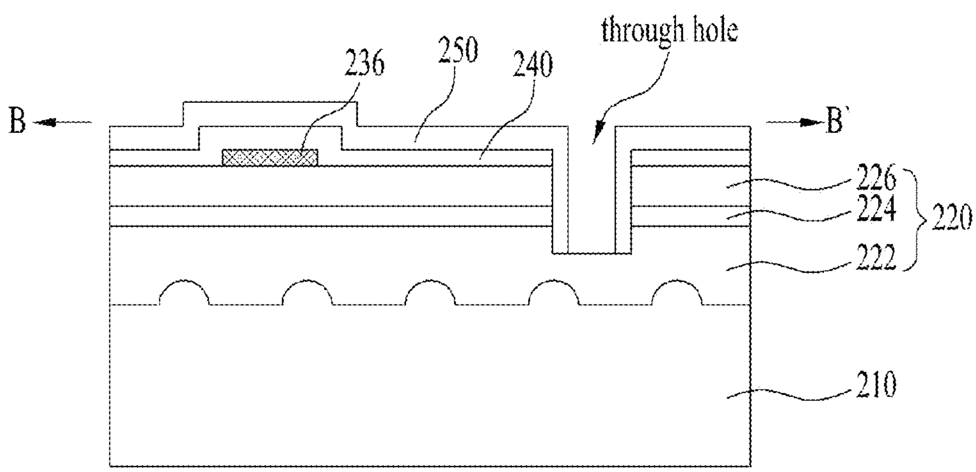

through hole
236
250
240
B
B'
226
224
220
222
210

Fig. 3l

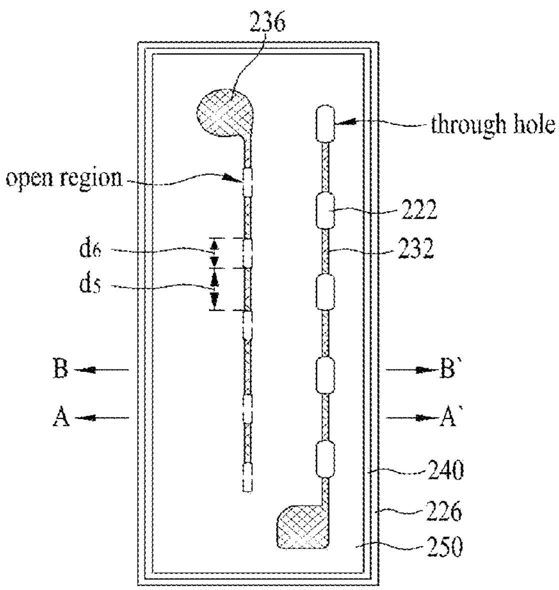

236
through hole
open region
222
d6
232
d5
B
B`
A
A`
240
226
250

Fig. 3m

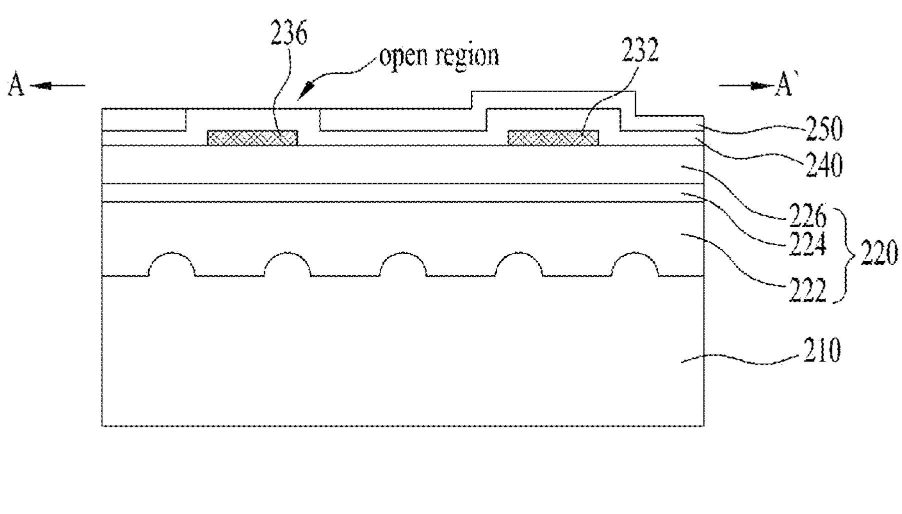

236
open region
232
A
A`
250
240
226
224
220
222
210

Fig. 3n

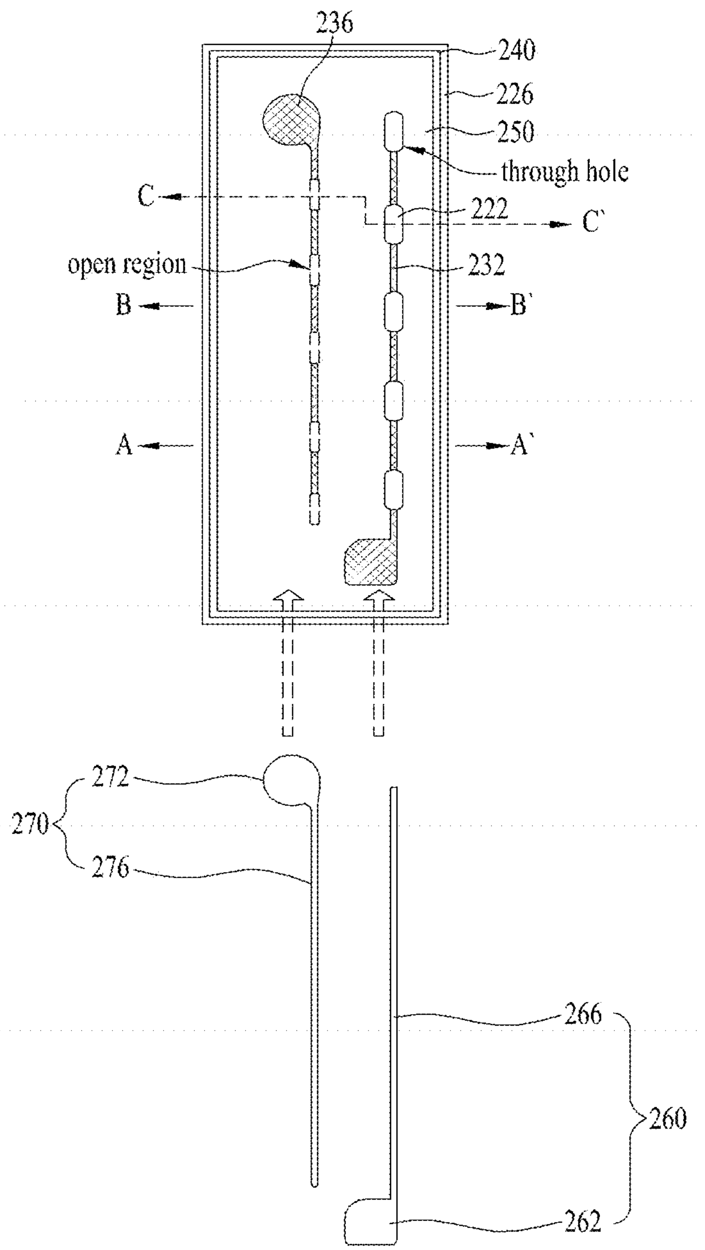

236
240
226
250
through hole
C
222
C`
open region
232
B
B`
A
A`
272
270
276
266
260
262

Fig. 3o

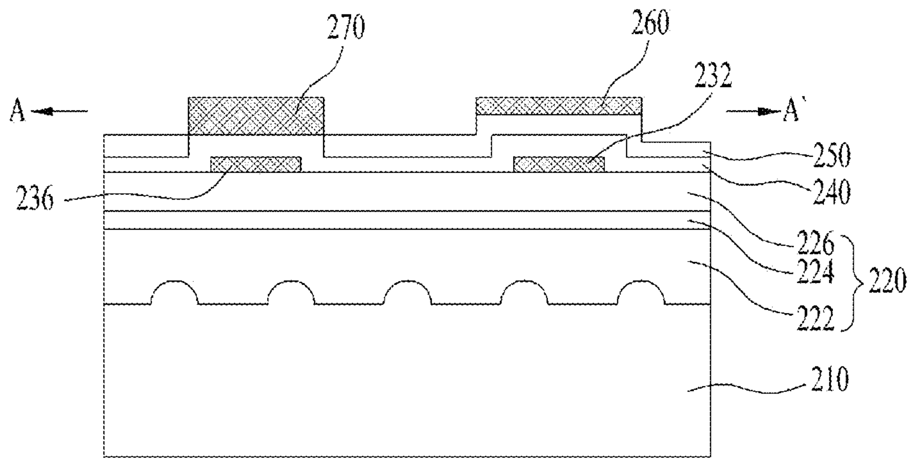

270
260
232
A
A`
250
240
236
226
224
220
222
210

Fig. 3p

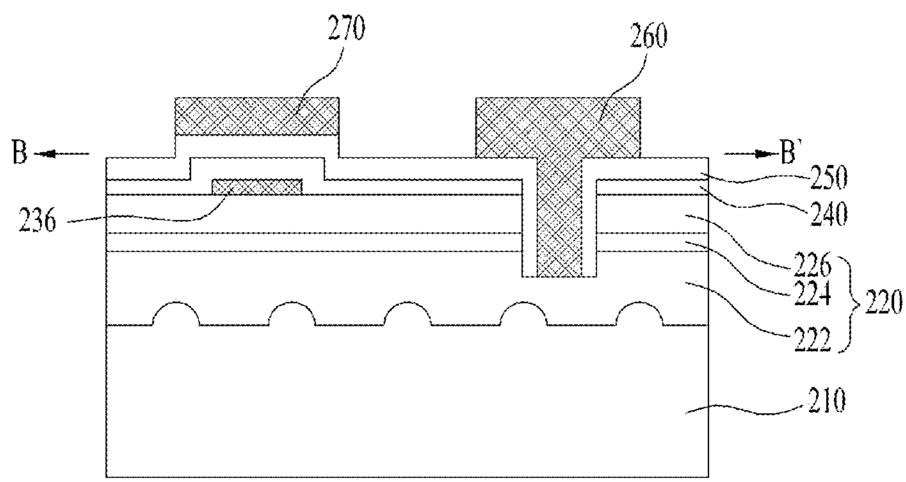

270
260
B
B`
250
240
236
226
224
220
222
210

Fig. 3q

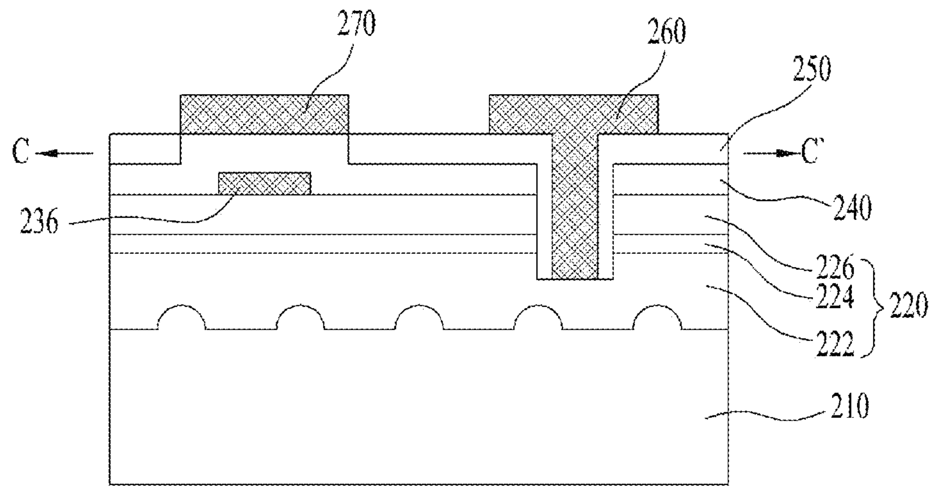

270
260
250
C
C'
236
240
226
224
220
222
210

Fig. 4a

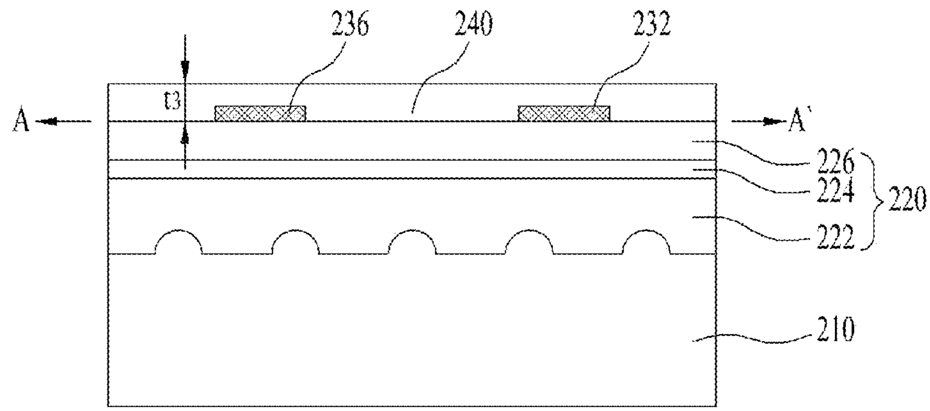

236
240
232
t3
A
A'
226
224
220
222
210

Fig. 4b

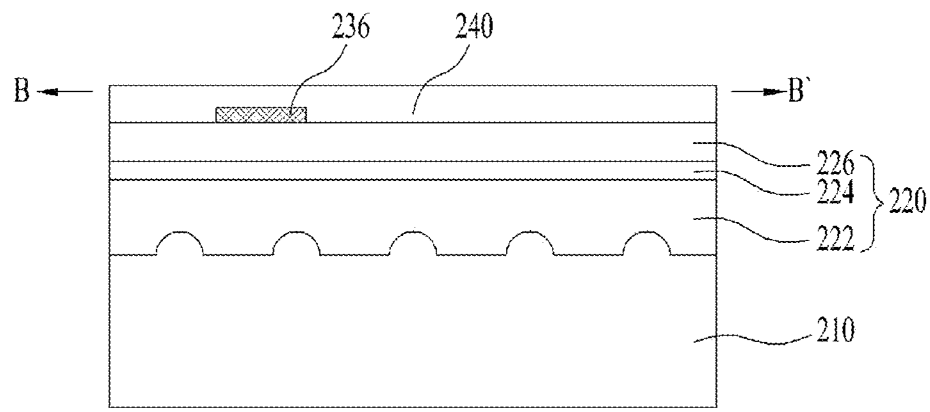

236
240
B
B`
226
224
220
222
210

Fig. 4c

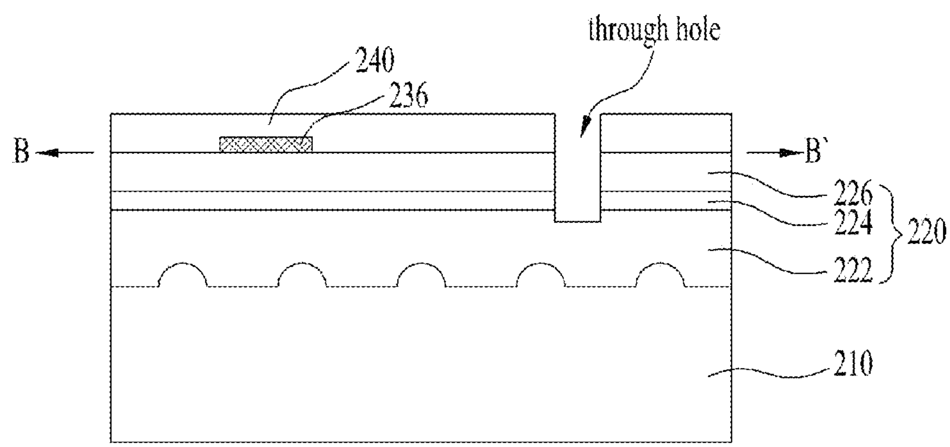

through hole
240
236
B
B`
226
224
220
222
210

Fig. 4d

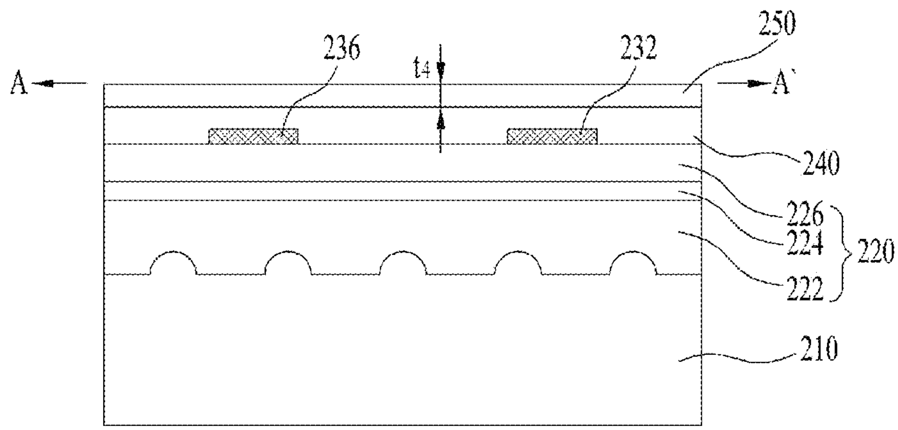

236
t4
232
250
A
A`
240
226
224
220
222
210

Fig. 4e

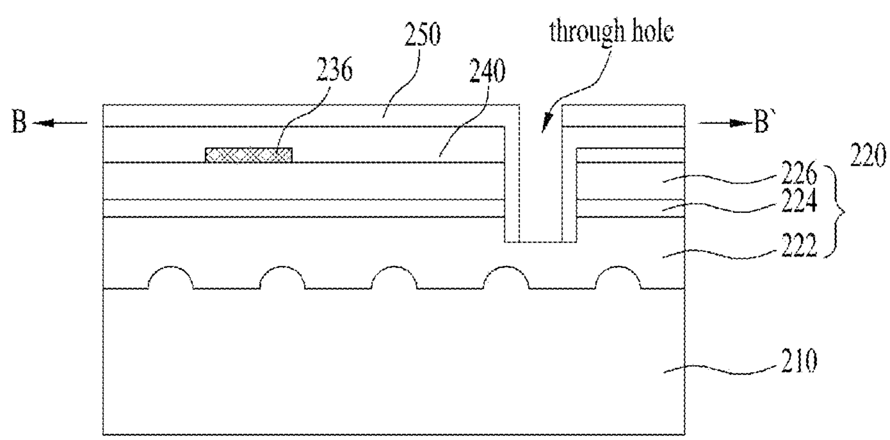

250
through hole
236
240
B
B`
220
226
224
222
210

Fig. 4f

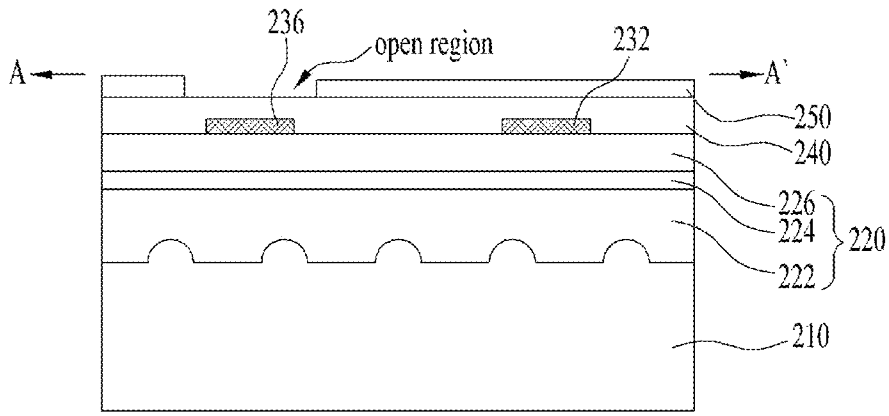

236
open region
232
A
A'
250
240
226
224
220
222
210

Fig. 4g

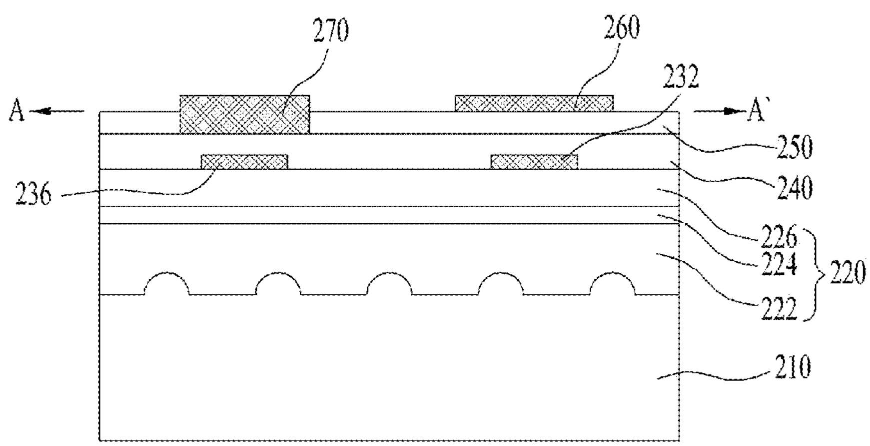

270
260
232
A
A'
250
240
236
226
224
220
222
210

Fig. 4h

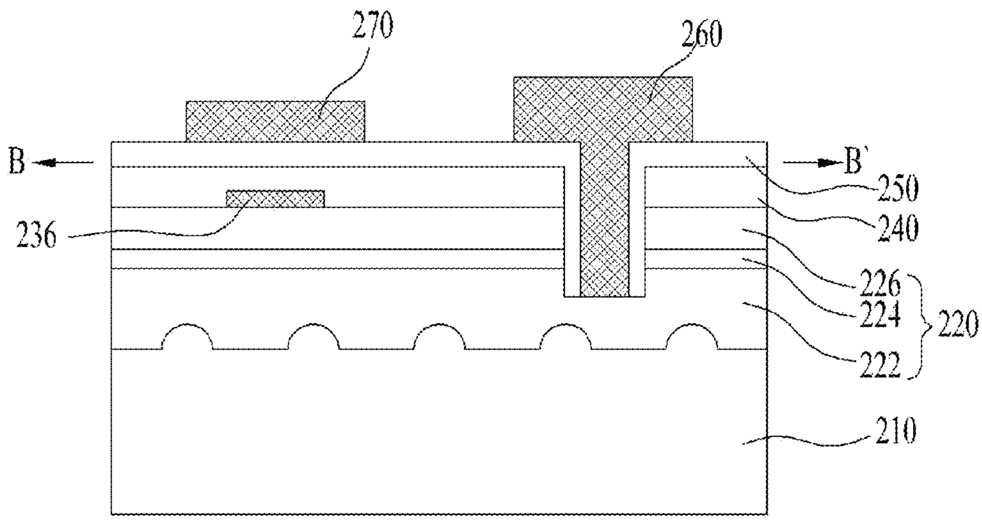

270
260
B
B`
250
240
236
226
224
220
222
210

Fig. 5a

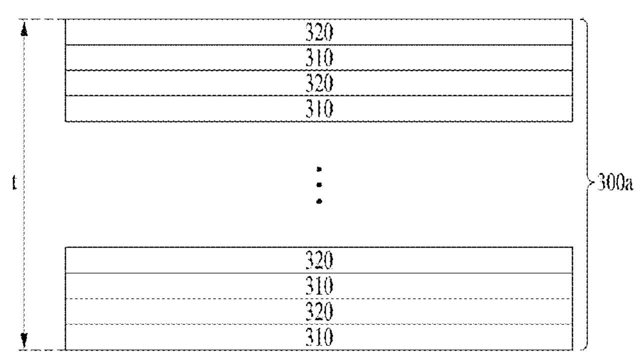

320
310
320
310
t
300a
320
310
320
310

Fig. 5b

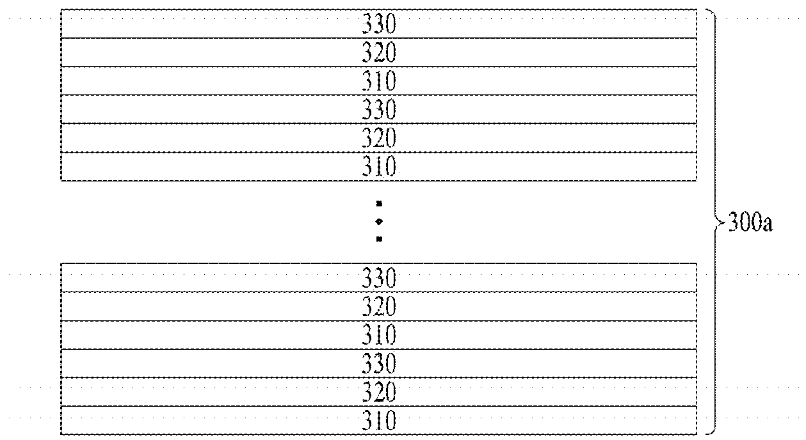

330
320
310
330
320
310
330
320
310
330
320
310
300a

Fig. 6a

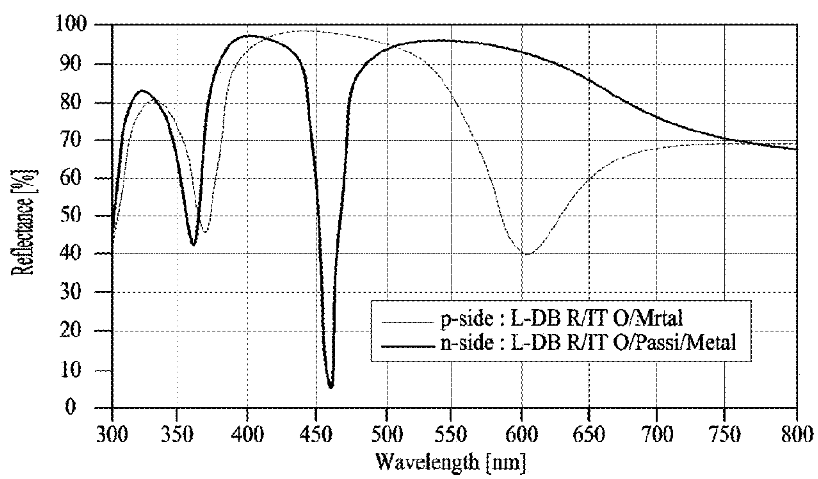

Reflectance [%]
Wavelength [nm]
p-side : L-DB R/IT O/Mrtal
n-side : L-DB R/IT O/Passi/Metal
100
90
80
70
60
50
40
30
20
10
0
300
350
400
450
500
550
600
650
700
750
800

Fig. 6b

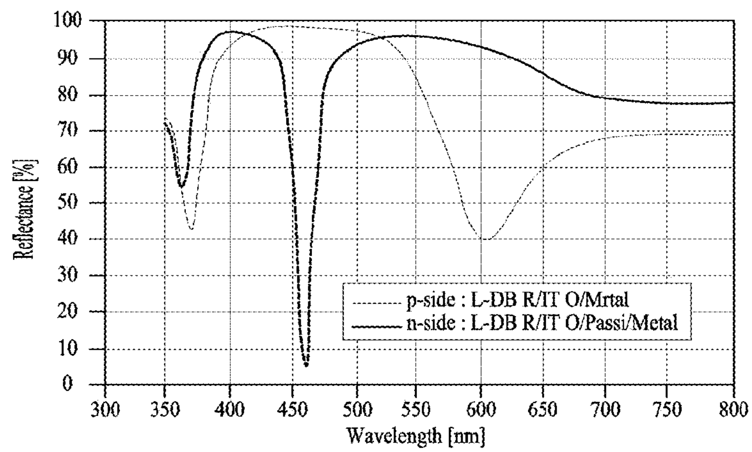


Fig. 7a

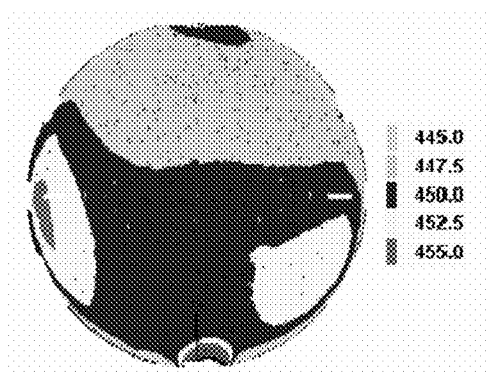


Fig. 7b

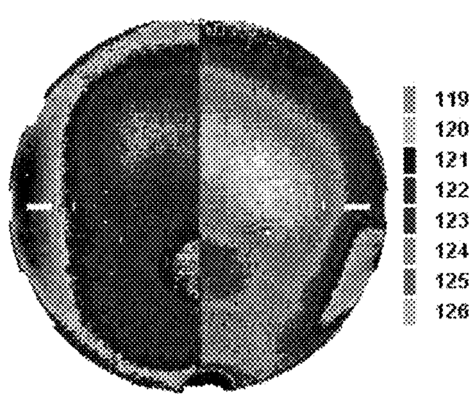
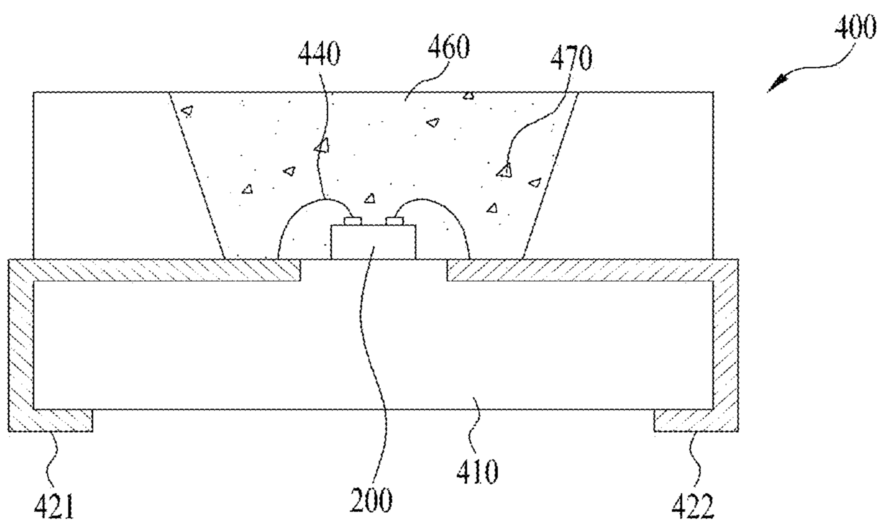


Fig. 8



LIGHT EMITTING DEVICE

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. §119 to Korean Patent Application No. 10-2014-0147926, filed in Korea on Oct. 29, 2014, which are hereby incorporated in its entirety by reference as if fully set forth herein.

TECHNICAL FIELD

Embodiments relate to a light emitting device.

BACKGROUND

Group III-V compound semiconductor materials such as GaN, AlGaN, and the like have various advantages such as wide, easily adjustable energy band gaps, and thus have been widely used for electronic devices in the field of optoelectronics.

Particularly, light emitting devices using Group III-V or II-VI compound semiconductor materials, such as light emitting diodes or laser diodes, have advantages in that they may be used to realize various colors such as red, green, blue, and ultraviolet (UV) colors with the development of thin film growth technology and device materials, and may also be used to realize highly effective white light beams by making use of fluorescent materials or combining colors, and have low power consumption, semi-permanent lifespan, rapid response time, safety, and environmental friendliness, compared to conventional light sources such as fluorescent lamps, incandescent lamps, etc.

Therefore, the light emitting devices have been increasingly applied to transmitter modules for optical communication systems, light emitting diode backlight units replacing cold cathode fluorescence lamps (CCFLs) constituting backlight units for liquid crystal display (LCD) devices, white light emitting diode lightings capable of replacing fluorescent lamps or incandescent lamps, car headlights, and traffic lights.

FIG. **1** is a diagram showing a conventional light emitting device.

A light emitting device **100** includes a substrate **110** formed of sapphire, and the like, a light emitting structure **120** arranged on the substrate **110** and including a first conductive semiconductor layer **122**, an active layer **124**, and a second conductive semiconductor layer **126**, and a first electrode **160** and a second electrode **170** arranged on the first conductive semiconductor layer **122** and second conductive semiconductor layer **126**, respectively.

As electrons injected through the first conductive semiconductor layer **122** and holes injected through the second conductive semiconductor layer **126** are combined at the active layer **124**, the light emitting device **100** emits light with energy determined by an innate energy band of a material used to form the active layer **124**. The light emitted from the active layer **124** may have varying colors, depending on compositions of the material forming the active layer **124**. In this case, the light may include blue light, UV or deep UV rays, etc.

The light emitting device **100** may be arranged in a light emitting device package. In this case, light with a first wavelength region emitted from the light emitting device **100** may excite a phosphor, which then may emit light with a second wavelength region as the phosphor is excited by the light with the first wavelength region. Here, the phosphor may be included in a molding part surrounding the light emitting device **100**, or may be arranged in the form of a phosphor film.

However, the above-described conventional light emitting device has the following drawbacks.

In the light emitted from the active layer **124**, light traveling toward the second electrode **170** may be absorbed into the second electrode **170**, resulting in degraded light efficiency of the light emitting device **100**.

SUMMARY

Embodiments provide a light emitting device having improved light efficiency.

In one embodiment, a light emitting device includes a light emitting structure including a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer, a first current blocking layer and a second current blocking layer arranged on the light emitting structure to be separated from each other, a light-transmitting conductive layer arranged on the first current blocking layer, the second current blocking layer and the light emitting structure, a first electrode and a second electrode electrically coupled to the first conductive semiconductor layer and the second conductive semiconductor layer, respectively, a through hole formed through the light-transmitting conductive layer, the second conductive semiconductor layer and the active layer to a portion of the first conductive semiconductor layer, and a through electrode arranged inside the through hole, wherein the through electrode does not overlap the first current blocking layer in a vertical direction.

The light emitting device may further include an insulation layer arranged between the first electrode and the first current blocking layer and between the second electrode and the second current blocking layer.

The through hole may be formed through the insulation layer.

The through electrode and the first current blocking layer may be linearly arranged in a horizontal direction.

The insulation layer may be arranged in the through hole to extend around the through electrode.

The first electrode may include a first bonding pad and a first branched-finger electrode.

The first bonding pad may be arranged at a first edge region of the light emitting device.

At least a portion of the first branched-finger electrode may overlap the through electrode and the first current blocking layer in a vertical direction.

The through electrode may have a length smaller than a distance between neighboring through electrodes.

The second electrode may include a second bonding pad and a second branched-finger electrode.

The second bonding pad may be arranged at a second edge region of the light emitting device.

A portion of the second branched-finger electrode may overlap the second current blocking layer in a vertical direction.

A portion of the insulation layer may be opened to form an open region, and the light-transmitting conductive layer may be exposed through the open region.

The light-transmitting conductive layer and the second electrode may be brought into direct contact at the open region.

The open region and the through electrode may be alternately arranged in a horizontal direction.

At least one of the first current blocking layer and the second current blocking layer may be a distributed Bragg reflector (DBR) or an omni-directional reflector (ODR).

In another embodiment, a light emitting device includes a light emitting structure comprising a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer, a first current blocking layer and a second current blocking layer having a DBR or ODR structure and arranged on the light emitting structure to be separated from each other, a light-transmitting conductive layer arranged on the first current blocking layer, the second current blocking layer and the light emitting structure and having the smallest thickness at regions corresponding respectively to the first current blocking layer and the second current blocking layer, a first electrode and a second electrode electrically coupled to the first conductive semiconductor layer and the second conductive semiconductor layer, respectively, a through hole formed through the light-transmitting conductive layer, the second conductive semiconductor layer, and the active layer to a portion of the first conductive semiconductor layer, and a through electrode arranged in the through hole.

The first current blocking layer may have a plurality of portions arranged spaced apart from each other.

The through hole may be formed through the light-transmitting conductive layer, the second conductive semiconductor layer, and the active layer to a portion of the first conductive semiconductor layer, the light emitting device may further include a through electrode arranged in the through hole, and a spacing between the portions constituting the first current blocking layer may be the same as a length of the through hole.

In still another embodiment, a light emitting device includes a light emitting structure comprising a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer, a first current blocking layer and a second current blocking layer arranged on the light emitting structure to be separated from each other, a light-transmitting conductive layer arranged on the first current blocking layer, the second current blocking layer and the light emitting structure, a first electrode and a second electrode electrically coupled to the first conductive semiconductor layer and the second conductive semiconductor layer, respectively, and an insulation layer arranged between the first electrode and the first current blocking layer and between the second electrode and the second current blocking layer, wherein a through hole is formed through the insulation layer, the light-transmitting conductive layer, the second conductive semiconductor layer, and the active layer to a portion of the first conductive semiconductor layer, the through hole does not overlap the first current blocking layer in a vertical direction, a portion of the insulation layer is opened to form an open region, and the light-transmitting conductive layer is exposed through the open region, and the open region and the through electrode are alternately arranged in a horizontal direction.

BRIEF DESCRIPTION OF THE DRAWINGS

Arrangements and embodiments may be described in detail with reference to the following drawings in which like reference numerals refer to like elements and wherein:

FIG. **1** is a diagram showing a conventional light emitting device;

FIGS. **2**A and **2**B are cross-sectional views showing one embodiment of a light emitting device;

FIGS. **3**A to **3**Q are cross-sectional views showing one embodiment of a method of manufacturing a light emitting device;

FIGS. **4**A to **4**H are diagrams showing another embodiment of a method of manufacturing a light emitting device;

FIGS. **5**A and **5**B are diagrams showing one embodiment of a current blocking layer of the light emitting device;

FIGS. **6**A and **6**B show simulation and measurement results in which optical powers of light emitting devices according to embodiments are simulated and measured in certain wavelength regions;

FIGS. **7**A and **7**B are diagrams showing wavelength distributions and optical powers of light emitted from the light emitting device according to one embodiment and a conventional light emitting device, respectively; and

FIG. **8** is a diagram showing one embodiment of a light emitting device package having the above-described light emitting device arranged therein.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Hereinafter, embodiments will be described with reference to the annexed drawings.

It will be understood that when an element is referred to as being "on" or "under" another element, it can be directly on/under the element, and one or more intervening elements may also be present. When an element is referred to as being "on" or "under", "under the element" as well as "on the element" can be included based on the element.

FIGS. **2**A and **2**B are cross-sectional views showing one embodiment of a light emitting device.

FIGS. **2**A and **2**B are cross-sectional views of one light emitting device **200**, as viewed in different directions.

The light emitting device **200** as shown in FIG. **2**A includes a substrate **210**, a light emitting structure **220**, a first current blocking layer **232**, a second current blocking layer **236**, a light-transmitting conductive layer **240**, an insulation layer **250**, a first electrode **260**, and a second electrode **270**.

The substrate **210** may be formed of a carrier wafer or a material suitable for growth of semiconductor materials, and may also be formed of a material showing excellent thermal conductivity. In this case, the substrate **210** may include a conductive substrate, or an insulating substrate. For example, the substrate **210** may be formed of at least one selected from the group consisting of sapphire (Al_2O_3), SiO_2, SiC, Si, GaAs, GaN, ZnO, GaP, InP, Ge, and $Ga_2 0_3$.

When the substrate **210** is formed of sapphire, and the like, and the light emitting structure **220** including GaN or AlGaN is arranged on the substrate **210**, a lattice mismatch between GaN or AlGaN and sapphire is very large, and a difference in thermal expansion coefficient between GaN or AlGaN and sapphire is significantly high, which leads to dislocation causing decrease in crystallinity, occurrence of melt-backs, cracks, and pits, interior surface morphology, and the like. Accordingly, a buffer layer (not shown) may be formed of AlN, etc.

Since a pattern is formed on a surface of the substrate **210** as shown in the drawings, light emitted from the light emitting structure **220** to travel toward the substrate **210** may be reflected on the pattern.

The light emitting structure **220** may include a first conductive semiconductor layer **222**, an active layer **224**, and a second conductive semiconductor layer **226**.

The first conductive semiconductor layer **222** may be realized using Group III-V and Group II-VI compound semiconductor materials, etc., and may be doped with a first conductive dopant. The first conductive semiconductor layer

222 may be formed of at least one selected from the group consisting of semiconductor materials having a composition expression of $Al_xIn_yGa_{(1-x-y)}N$ ($0 \le x \le 1$, $0 \le y \le 1$, and $0 \le x+y \le 1$), for example, AlGaN, GaN, InAlGaN, AlGaAs, GaP, GaAs, GaAsP, and AlGaInP.

When the first conductive semiconductor layer **222** is an n-type semiconductor layer, the first conductive dopant may include an n-type dopant such as Si, Ge, Sn, Se, Te, etc. The first conductive semiconductor layer **222** may be formed in a single-layered or multilayered structure, but the disclosure is not limited thereto.

The active layer **224** may be arranged between the first conductive semiconductor layer **222** and the second conductive semiconductor layer **226**, and may have one structure selected from the group consisting of a single well structure, a multiple well structure, a single quantum well structure, a multiple quantum well (MQW) structure, a quantum dot structure, and a quantum wire structure.

The active layer **224** may be formed in at least one pair structure of a well layer and a barrier layer, for example, AlGaN/AlGaN, InGaN/GaN, InGaN/InGaN, AlGaN/GaN, InAlGaN/GaN, GaAs(InGaAs)/AlGaAs, and GaP(InGaP)/AlGaP, using a Group III-V compound semiconductor material, but the disclosure is not limited thereto.

The well layer may be formed of a material having a lower energy band gap than the barrier layer.

The second conductive semiconductor layer **226** may be formed of a semiconductor compound. The second conductive semiconductor layer **226** may be realized using Group III-V and Group II-VI compound semiconductor materials, etc., and may be doped with a second conductive dopant. The second conductive semiconductor layer **226** may, for example, be formed of at least one selected from the group consisting of semiconductor materials having a composition expression of $In_xAl_yGa_{1-x-y}N$ ($0 \le x \le 1$, $0 \le y \le 1$, and $0 \le x+y \le 1$), for example, AlGaN, GaNAlInN, AlGaAs, GaP, GaAs, GaAsP, and AlGaInP. For example, the second conductive semiconductor layer **226** may be formed of $Al_xGa_{(1-x)}N$.

When the second conductive semiconductor layer **226** is a p-type semiconductor layer, the second conductive dopant may include a p-type dopant such as Mg, Zn, Ca, Sr, Ba, etc. The second conductive semiconductor layer **226** may be formed in a single-layered or multilayered structure, but the disclosure is not limited thereto.

Although not shown, an electron blocking layer may be arranged between the active layer **224** and the second conductive semiconductor layer **226**. The electron blocking layer may be formed in a superlattice structure. In the superlattice structure, for example, AlGaN doped with the second conductive dopant may be arranged, and a plurality of layers formed of GaN and having different composition ratios of aluminum may also be alternately arranged.

The first current blocking layer **232** and the second current blocking layer **236** may be arranged on the second conductive semiconductor layer **226** to be spaced apart from each other. In this case, the first current blocking layer **232** and the second current blocking layer **236** may be selectively arranged on a portion of the second conductive semiconductor layer **226**, and may be made of an insulating material.

The light-transmitting conductive layer **240** may be arranged on the second conductive semiconductor layer **226**, the first current blocking layer **232**, and the second current blocking layer **236**. In this case, the light-transmitting conductive layer **240** may be made of indium tin oxide (ITO), etc. However, since the second conductive semiconductor layer **226** has poor current spreading characteristics, the light-transmitting conductive layer **240** may receive a current from the second electrode **270**.

The light-transmitting conductive layer **240** may have a constant thickness t_1, and thus a height of the light-transmitting conductive layer **240** may be greater at regions corresponding to the first current blocking layer **232** and the second current blocking layer **236** than the other regions thereof.

The insulation layer **250** may be arranged on the light-transmitting conductive layer **240**. In this case, a portion of the insulation layer **250** may be opened so that the light-transmitting conductive layer **240** is exposed through an upper region of the second current blocking layer **236**. The insulation layer **250** may be made of an oxide or a nitride. Specifically, the insulation layer **250** may be formed as a silicon oxide (SiO_2) layer, an oxynitride layer, or an aluminum oxide layer.

In addition, since the insulation layer **250** may be formed in a constant thickness t_2 at a region other than the above-described open region, the height of the insulation layer **250** may be greater at a region corresponding to the first current blocking layer **232** than the other regions thereof.

The first electrode **260** and the second electrode **270** may be arranged on the insulation layer **250** to be spaced apart from each other. In this case, the first electrode **260** and the second electrode **270** may be arranged on regions corresponding to the first current blocking layer **232** and the second current blocking layer **236**, respectively.

The insulation layer **250** may be arranged between the first electrode **260** and the light-transmitting conductive layer **240**, or the second electrode **270** and the light-transmitting conductive layer **240** may be brought into direct contact at the above-described open region of the insulation layer **250**.

FIG. **2**A is a cross-sectional view taken along line A-A' of the light emitting device **200**, and FIG. **2**B is a cross-sectional view taken along line B-B' of the light emitting device **200**.

The substrate **210** and the light emitting structure **220** have the same structure as the light emitting device **200** as shown in FIG. **2**A, but are different from the light emitting device **200** in that the first current blocking layer **232** is not arranged in a direction taken along line B-B'.

The second current blocking layer **236** may be arranged on the second conductive semiconductor layer **226**, and the light-transmitting conductive layer **240** may be arranged on the second conductive semiconductor layer **226** and the second current blocking layer **236**.

The light-transmitting conductive layer **240** may have a constant thickness t_1, and thus a height of the light-transmitting conductive layer **240** may be greater at a region corresponding to the second current blocking layer **236** than the other regions thereof.

The insulation layer **250** may be arranged on the light-transmitting conductive layer **240**. In this case, the insulation layer **250** may have a constant thickness t_2, and thus a height of the insulation layer **250** may be greater at a region corresponding to the second current blocking layer **236** in a vertical direction than the other regions thereof.

Additionally, the second electrode **270** may be arranged on the insulation layer **250**. In this case, the second electrode **270** may be arranged to correspond to the second current blocking layer **236** in a vertical direction. In addition, the light-transmitting conductive layer **240** and the second electrode **270** may not be brought into direct contact, unlike that in FIG. **2**A.

In addition, a through hole is formed downward from the first electrode **260**, as shown in FIG. **2**B. The through hole may be formed through the light-transmitting conductive layer **240**, the second conductive semiconductor layer **226**, and the active layer **224** so that the through hole spans from the insulation layer **250** to a portion of the first conductive semiconductor layer **222**.

Further, the insulation layer **250** may be arranged on inner sidewalls of the through hole to extend to the inner side-walls. The first electrode **260** is formed on the through hole. In this case, since the first electrode **260** is arranged in the through hole to extend to an inner part of the through hole, the first conductive semiconductor layer **222** and the first electrode **260** may be brought into direct electrical contact at a bottom surface of the through hole. Here, a portion of the first electrode **260** arranged inside the through hole may be referred to as a through electrode.

FIGS. **3**A to **3**P are diagrams showing one embodiment of a method of manufacturing a light emitting device.

As shown in FIG. **3**A, the first light emitting structure **220** is allowed to grow on the substrate **210**.

The substrate **210** may be formed of sapphire as described above, and, although not shown, the above-described buffer layer (not shown) may be allowed to grow prior to growth of the light emitting structure **220**.

The first conductive semiconductor layer **222** may be allowed to grow using a method such as chemical vapor deposition (CVD), molecular beam epitaxy (MBE), sputtering, or hydride vapour phase epitaxy (HVPE). The first conductive semiconductor layer **222** has the same composition as described above, and bis(ethyl cyclopentadienyl) magnesium ((EtCp$_2$Mg) $\{Mg(C_2H_5C_5H_4)_2\}$) including p-type impurities such as trimethyl gallium gas (TMGa), ammonia gas (NH_3), nitrogen gas (N_2), and magnesium (Mg) may be injected into a chamber at a temperature of approximately 1,000° C. to form a p-type GaN layer, but the disclosure is not limited thereto.

In addition, the active layer **224** is allowed to grown on the first conductive semiconductor layer **222**. For the active layer **224**, for example, trimethyl gallium gas (TMGa), ammonia gas (NH_3), nitrogen gas (N_2), and trimethyl indium gas (TMIn) may be injected at a temperature of approximately 700° C. to 800° C. to form a MQW structure, but the disclosure is not limited thereto.

Additionally, the second conductive semiconductor layer **226** is allowed to grown on the active layer **224**. In this case, the second conductive semiconductor layer **226** may have the same composition as described above.

The second conductive semiconductor layer **226** is allowed to grown by supplying Zn and O_2 at a temperature of approximately 500° C., and may be doped with an n-type dopant. For example, the second conductive semiconductor layer **226** may be doped with Si, Ge, Sn, Se, Te, etc. The second conductive semiconductor layer **226** may be formed using a method such as metal organic (MO)-CVD, plasma-enhanced (PE)-CVD, or sputtering, and Al, Fe and Ga may be added thereto.

In addition, as shown in FIGS. **3**B and **3**C, the first current blocking layer **232** and the second current blocking layer **236** are allowed to grown on the second conductive semi-conductor layer **226**.

The first current blocking layer **232** and the second current blocking layer **236** may be made of an insulating material. Specifically, the first current blocking layer **232** and the second current blocking layer **236** may be a distributed Bragg reflector (DBR) or an omni-directional reflector (ODR), and thus specific configurations thereof will be described below.

The first current blocking layer **232** and the second current blocking layer **236** may be selectively formed using a mask, or may be formed by forming one current blocking layer on an entire surface of the second conductive semi-conductor layer **226** and selectively removing the current blocking layer.

A section of the first current blocking layer **232** and the second current blocking layer **236** is shown in FIG. **3**B. Here, a width d_1 of the first current blocking layer **232** and a width d_2 of the second current blocking layer **236** may be the same as or different from each other. In addition, the first current blocking layer **232** may be formed to have a pattern. In this case, a length d_3 of one portion of the first current blocking layer **232** formed to have the pattern may be larger than a spacing d_4 between respective portions of the first current blocking layer **232**, but the disclosure is not particularly limited thereto. Here, the spacing d_4 between the respective portions of the first current blocking layer **232** may be a length of the through hole or the through electrode.

A section taken along line A-A' in FIG. **3**B is shown in FIG. **3**C. Here, a width w_1 of the first current blocking layer **232** and a width w_2 of the second current blocking layer **236** may be the same as or different from each other.

In addition, as shown in FIGS. **3**D to **3**F, the light-transmitting conductive layer **240** may be formed on the second conductive semiconductor layer **226** on which the first current blocking layer **232** and the second current blocking layer **236** are formed.

A section taken along line A-A' in FIG. **3**D is shown in FIG. **3**E, and a section taken along line B-B' in FIG. **3**D is shown in FIG. **3**F.

As shown in FIG. **3**E, since the light-transmitting conductive layer **240** may be arranged on the first current blocking layer **232** and the second current blocking layer **236** so that the light-transmitting conductive layer **240** has a constant thickness t_1, a height of the light-transmitting conductive layer **240** may be greater at regions corresponding to the first current blocking layer **232** and the second current blocking layer **236** than the other regions thereof.

The second current blocking layer **236** may be integrally arranged, and the first current blocking layer **232** may have a plurality of portions spaced at constant intervals, as shown in FIGS. **3**B and **3**D. In addition, as shown in FIG. **3**F, the second current blocking layer **236** may be formed on the second conductive semiconductor layer **226**, but the first current blocking layer **232** may not be formed on the second conductive semiconductor layer **226**, as viewed from a section taken along line B-B' in FIG. **3**D.

Additionally, as shown in FIGS. **3**G and **3**H, a through hole may be formed through the second conductive semi-conductor layer **226** and the active layer **224** so that the through hole spans from the light-transmitting conductive layer **240** to a portion of the first conductive semiconductor layer **222**.

As shown in FIG. **3**G, through holes may be formed at regions between the first current blocking layers **232**. A section taken along line B-B' in FIG. **3**G is shown in FIG. **3**H. In this case, a section taken along line A-A' in FIG. **3**G may be the same in FIG. **3**E since the through holes are not formed.

In addition, as shown in FIGS. **3**I to **3**K, the insulation layer **250** may be formed on the light-transmitting conductive layer **240**.

As shown in FIG. **3**I, the insulation layer **250** may be formed on the light-transmitting conductive layer **240** so that the insulation layer **250** has a constant thickness. A section taken along line A-A' in FIG. **3**I is shown in FIG. **3**J. Here, since the insulation layer **250** is formed on the light-transmitting conductive layer **240** so that the insulation layer **250** has a constant thickness t_2, a height of the insulation layer **250** may be greater at regions corresponding to the first current blocking layer **232** and the second current blocking layer **236** than the other regions thereof.

A section taken along line B-B' in FIG. **3**I is shown in FIG. **3**K. Here, the insulation layer **250** may be arranged on inner sides of the through hole to extend to the inner sides of the through hole. In this case, the first conductive semiconductor layer **222** may be exposed through a bottom surface of the through hole.

As shown in FIGS. **3**J and **3**K, the through hole does not overlap the first current blocking layer **232** in a vertical direction. In this case, it could be seen that, since the through hole and the first current blocking layer **232** are linearly arranged in a horizontal direction, shapes of the through hole and the first current blocking layer **232** are similar to that of the first electrode **260** shown in FIG. **3**N, as viewed in a horizontal direction.

In addition, as shown in FIGS. **3**L and **3**M, an open region is formed on the second current blocking layer **236** in the insulation layer **250**. Here, the above-described open region may be alternately arranged with the through holes or through electrodes in a horizontal direction without facing the through holes or through electrodes, as shown in FIG. **3**L.

As shown in FIG. **3**L and FIG. **3**N as will be described later, the second current blocking layer **236** is not shown to correspond to the open region for the sake of convenience of description, but the light-transmitting conductive layer **240** and the second current blocking layer **236** may be actually arranged below the open region.

As shown in FIG. **3**L, a length d_6 of one of the open regions, and a length d_5 between the respective open regions through which the second current blocking layer **236** is exposed may be the same as or different from each other.

FIG. **3**M is a cross-sectional view taken along line A-A' in FIG. **3**L. Here, the light-transmitting conductive layer **240** may be exposed since the insulation layer **250** is removed from a region corresponding to the second current blocking layer **236** in a vertical direction using a method such as etching. In this case, a section taken along line B-B' in FIG. **3**L may be the same in FIG. **3**K.

In addition, as shown in FIG. **3**N, the first electrode **260** and the second electrode **270** are arranged using a method such as vapor deposition. The first electrode **260** and the second electrode **270** may be formed in a single-layered or multilayered structure to include at least one selected from the group consisting of aluminum (Al), titanium (Ti), chromium (Cr), nickel (Ni), copper (Cu), and gold (Au).

The first electrode **260** may include a first bonding pad **262** and a first branched-finger electrode **266**, and the second electrode **270** may include a second bonding pad **272** and a second branched-finger electrode **276**.

The first bonding pad **262** and the second bonding pad **272** may be arranged on first and second edge regions of the light emitting device, respectively, and bonded to the first and second edge regions by means of wires. In this case, the first and second edge regions may be regions on facing corners, as shown in FIG. **3**N.

In addition, as shown in FIG. **3**N, the first branched-finger electrode **266** may be arranged on a region which overlap the through hole (through electrode) and the first current blocking layer **232** in a vertical direction.

The first electrode **260** and the second electrode **270** may be formed of the above-listed materials using a method such as vapor deposition. In this case, the first electrode **260** and the second electrode **270** may be deposited to correspond to the first current blocking layer **232** and the second current blocking layer **236**, respectively.

As shown in FIG. **3**N, a portion of the second branched-finger electrode **276** may be arranged to overlap the second current blocking layer **236** in a vertical direction.

Cross-sectional views taken along lines A-A', B-B', and C-C' of the finished light emitting device are shown in FIGS. **3**O, **3**P, and **3**Q, respectively. Here, the light emitting device shown in FIGS. **3**O and **3**P is the same as the light emitting device **200** shown in FIGS. **2**A and **2**B.

In the light emitting device **200** according to one embodiment, the second current blocking layer **236**, the light-transmitting conductive layer **240**, and the insulation layer **250** may be arranged between the second conductive semiconductor layer **226** and the second electrode **270**, and the second current blocking layer **236** and the light-transmitting conductive layer **240** may be arranged between the second conductive semiconductor layer **226** and the second electrode **270** when the light-transmitting conductive layer **240** is in an open region.

In addition, the first electrode **260** may be brought into direct electrical contact with the first conductive semiconductor layer **222** through the through hole formed at a region corresponding to the first conductive semiconductor layer **222**. Additionally, the first current blocking layer **232**, the light-transmitting conductive layer **240**, the insulation layer **250**, and the first electrode **260** may be arranged on the first current blocking layer **232** in a region in which the through hole is not formed.

A cross-sectional view taken along line C-C' of the light emitting device is shown in FIG. **3**Q. A section of a neighboring region of the first electrode **260** shown in FIG. **3**Q is similar to a section shown in FIG. **3**P, and a section of a neighboring region of the second electrode **270** is similar to a section shown in FIG. **3**O.

FIGS. **4**A to **4**H are diagrams showing another embodiment of a method of manufacturing a light emitting device. Hereinafter, configurations of the method of manufacturing a light emitting device according to one embodiment, which are different from the above-described embodiments, will be mainly described for clarity.

The light-transmitting conductive layer **240** may be formed on the second conductive semiconductor layer **226** on which the first current blocking layer **232** and the second current blocking layer **236** are formed. A section taken along line A-A' is shown in FIG. **4**A, and a section taken along line B-B' is shown in FIG. **4**B.

As shown in FIG. **4**A, since the transmitting conductive layer **240** is arranged on the first current blocking layer **232** and the second current blocking layer **236** so that the light-transmitting conductive layer **240** has a thickness t_3. Here, the thickness t_3 may be the same as or different from the thickness t_1 shown in FIG. **3**E. Unlike the above-described embodiments, the transmitting conductive layer **240** may not have a constant thickness since a top surface of the light-transmitting conductive layer **240** is formed to be flush with each other. Therefore, the above-described thickness t_3 may be a thickness of a region of the light-transmitting conductive layer **240** on which the first current blocking layer **232** and the second current blocking layer **236** are not arranged.

In addition, the light-transmitting conductive layer **240** may have the smallest thickness at regions corresponding to the first current blocking layer **232** and the second current blocking layer **236** in a vertical direction.

Additionally, as shown in FIG. **4**C, a through hole may be formed through the second conductive semiconductor layer **226** and the active layer **224** so that the through hole spans from the light-transmitting conductive layer **240** to a portion of the first conductive semiconductor layer **222**.

A cross-sectional view taken along line B-B' of the light emitting device is shown in FIG. **4**C. Here, the through hole may not be formed in a cross-sectional view taken along line A-A' of the light emitting device.

In addition, as shown in FIGS. **4**D and **4**E, the insulation layer **250** may be formed on the light-transmitting conductive layer **240**.

A section taken along line A-A' of the light emitting device is shown in FIG. **4**D. Here, the insulation layer **250** may be formed on the light-transmitting conductive layer **240** so that the insulation layer **250** has a constant thickness t_4. In this case, the thickness t_4 may be the same as or different from the thickness t_2 of the insulation layer **250** according to the above-described embodiments.

A section taken along line B-B' of the light emitting device is shown in FIG. **4**E. Here, the insulation layer **250** may be arranged on inner sides of the through hole to extend to the inner sides of the through hole. In this case, the first conductive semiconductor layer **222** may be exposed through a bottom surface of the through hole.

Additionally, as shown in FIG. **4**F, an open region is formed in a region of the insulation layer **250** corresponding to the second current blocking layer **236**. Here, the above-described open region may be alternately arranged with the through hole or through electrode without facing the through hole or through electrode in a horizontal direction (see FIG. **3**L)

Cross-sectional views taken along lines A-A' and B-B' of the finished light emitting device are shown in FIGS. **4**G and **4**H, respectively.

As shown in FIG. **4**G, since the second electrode **270** is arranged on the above-described open region of the insulation layer **250**, a bottom surface of the second electrode **270** comes in contact with the light-transmitting conductive layer **240**, and some of sides of the second electrode **270** come in contact with the insulation layer **250**. In this case, since the first electrode **260** is arranged on a surface of the insulation layer **250**, the first electrode **260** may be electrically separated from the light-transmitting conductive layer **240**.

As shown in FIG. **4**H, since the second electrode **270** is arranged on a surface of the insulation layer **250**, the second electrode **270** may be electrically separated from the light-transmitting conductive layer **240**, and the first electrode **260** may come in direct electrical contact with the first conductive semiconductor layer **222** via the through hole.

FIGS. **5**A and **5**B are diagrams showing one embodiment of a current blocking layer of the light emitting device.

A current blocking layer **300*a*** may be either the first current blocking layer **232** or the second current blocking layer **236**. The current blocking layer **300*a*** may be a DBR or an ODR. Here, the current blocking layer **300*a*** may be DBR when a plurality of insulation layers are alternately arranged, the current blocking layer **300*a*** may be an ODR when insulation layers and conductive layers are alternately arranged. In this case, the above-described conductive layer may be made of a metal.

As shown in FIG. **5**A, the current blocking layer **300*a*** may include first layers **310** and second layers **320** alternately arranged therein. Each of the first layers **310** and the second layers **320** may include an insulating material. By way of example, each of the first layers **310** and the second layers **320** may include TiO_2, SiO_2, etc.

For example, TiO_2 having a refractive index of 2.4 to 3.0 may be used in the first layers **310**, and SiO_2 having a refractive index of 1.4 to 1.45 may be used in the second layers **320**.

The first layers **310** and the second layers **320** may be arranged to include SiO_2, Si_xO_y, AlAs, GaAs, Al_xIn_yP, Ga_xIn_yP, and the like in addition to the above-described combinations.

As shown in FIG. **5**B, the current blocking layer **300*a*** may include first layers **310**, second layers **320** and third layers **330** alternately arranged therein. Each of the first layers **310**, the second layers **320**, and the third layers **330** may include GaN, GaP, SiO_2, RuO_2, Ag, etc. For example, GaP may be used in the first layers **310**, SiO_2 may be used in the second layers **320**, and Ag may be used in the third layers **330**. In this case, the current blocking layer **300*a*** may serve as an ODR.

In the above-described light emitting device, the first current blocking layer and the second current blocking layer may be formed as reflective layers such as a DBR or an ODR to reflect light emitted from the active layer and traveling toward the first electrode or electrode, thereby preventing the light from being absorbed into the first or second electrode.

In addition, as shown in FIG. **2**A, the insulation layer is arranged on the first current blocking layer, as viewed from a section taken along line A-A' of the light emitting device, and the insulation layer is arranged on the second current blocking layer, as viewed from a section taken along line B-B'. Such a structure may prevent an optical power from decreasing in a certain wavelength region.

FIGS. **6**A and **6**B show simulation and measurement results in which optical powers of light emitting devices according to embodiments are simulated and measured in certain wavelength regions.

It could be seen that the optical power is dramatically lowered in a wavelength region of approximately 450 nm in the conventional light emitting device indicated by dark line in FIGS. **6**A and **6**B, but the optical power is not dramatically lowered in the light emitting device indicated by blurred line.

The light emitting device according to one embodiment may have a point contact structure in which the first electrode and the second electrode come in contact with the first conductive semiconductor layer and the light-transmitting conductive layer, respectively, at the through hole and the open region. In this case, a DBR or an ODR may be used as the current blocking layer. Since the insulation layer is arranged at a region other than the through hole and the open region, a degree of absorption of light reflected on the DBR or ODR, particularly light within a blue wavelength region, may be reduced, compared to the conventional light emitting device.

FIGS. **7**A and **7**B are diagrams showing wavelength distributions and optical powers of light emitted from the light emitting device according to one embodiment and a conventional light emitting device, respectively.

A left semicircular region of FIG. **7**A is a diagram showing a wavelength distribution of the light emitting device in which the current blocking layer is formed of silicon oxide (SiO_2), and a right semicircular region of FIG. **7**A is a diagram showing a wavelength distribution of the light emitting device in which the current blocking layer is formed of DBR according to one embodiment.

The light emitting device in the left semicircular region of FIG. **7**A has an average wavelength distribution of 450.9 nm, and the light emitting device in the right semicircular region of FIG. **7**A has an average wavelength distribution of 450.4 nm. From these results, it could be seen that there is no great difference in wavelength distribution of light emitted from the light emitting device according to one embodiment, compared to the conventional light emitting device.

A left semicircular region of FIG. **7**B is a diagram showing an optical power of the light emitting device in which the current blocking layer is formed of silicon oxide (SiO_2), and a right semicircular region of FIG. **7**B is a diagram showing an optical power of the light emitting device in which the current blocking layer is formed of DBR according to one embodiment.

The light emitting device in the left semicircular region of FIG. **7**B has an optical power of 122.3 mW, and the light emitting device in the right semicircular region of FIG. **7**B has an optical power of 124.5 mW. From these results, it could be seen that the optical power of the light emitting device according to one embodiment is improved, compared to the conventional light emitting device.

FIG. **8** is a diagram showing one embodiment of a light emitting device package having the above-described light emitting device arranged therein.

A light emitting device package **400** according to one embodiment included a body **410** including a cavity, first and second lead frames **421** and **422** installed at the body **410**, the above-described light emitting device **200** according to one embodiment installed at the body **410** and electrically coupled to the first and second lead frames **421** and **422**, and a molding part **460** formed in the cavity.

The body **410** may be formed to include a silicon material, a synthetic resin material, or a metal material. Although not shown, when the body **410** is made of a conductive material such as a metal material, a surface of the body **410** is coated with the insulation layer to prevent electrical short circuits between the first and second lead frames **421** and **422**. The cavity may be formed in the package body **410**, and the light emitting device **200** may be arranged on a bottom surface of the cavity.

The first lead frame **421** and the second lead frame **422** are electrically separated from each other to supply a current to the light emitting device **200**. In addition, the first and second lead frames **421** and **422** may reflect light generated at the light emitting device **200** to improve light efficiency, and may radiate heat generated at the light emitting device **200**.

The light emitting device **200** may be configured according to the above-described embodiments, and thus may be electrically coupled to the first lead frame **421** and the second lead frame **422** by means of wires **440**.

The light emitting device **200** may be fixed in a bottom surface of the package body **410** using a conductive paste (not shown), and the molding part **460** may protect the light emitting device **200** by covering the light emitting device **200**. In this case, since the phosphor **470** is included in the molding part **460**, the phosphor **470** may be excited by light with a first wavelength region emitted from the light emitting device **200** to emit light with a second wavelength region.

The one or plurality of light emitting devices according to the above-described embodiments may be mounted on the light emitting device package **400**, but the disclosure is not limited thereto.

The above-described light emitting device and light emitting device package may be used as a light source for lighting systems. By way of example, the light emitting device and light emitting device package may be used in light emitting apparatuses such as backlight units for image display devices, lightings, etc.

When the light emitting device and light emitting device package is used in the backlight units for image display devices, the light emitting device and light emitting device package may be used as an edge-type backlight unit or a direct-type backlight unit. On the other hand, when the light emitting device and light emitting device package is used in the lightings, the light emitting device and light emitting device package may be used as a luminaire or a bulb-type light source.

As is apparent from the above description, the light emitting device according to one embodiment may have a point contact structure in which the first electrode and the second electrode come in contact with the first conductive semiconductor layer and the light-transmitting conductive layer, respectively, at the through hole and the open region. In this case, a DBR or an ODR may be used as the current blocking layer. Since the insulation layer is arranged at a region other than the through hole and the open region, a degree of absorption of light reflected on the DBR or ODR, particularly light within a blue wavelength region, may be reduced, compared to the conventional light emitting device.

Therefore, the wavelength distributions of light emitted from the light emitting device according to one embodiment does not significantly differ from that of the conventional light emitting device, and thus the optical power may be improved, compared to the conventional light emitting device.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A light emitting device comprising:

a light emitting structure comprising a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer arranged in a vertical direction;

a first current blocking layer and a second current blocking layer arranged on the light emitting structure to be separated from each other;

a light-transmitting conductive layer arranged on the first current blocking layer and the second current blocking layer and the light emitting structure;

a first electrode and a second electrode electrically coupled to the first semiconductor layer and the second conductive semiconductor layer, respectively;

a through hole formed through the light-transmitting conductive layer, the second conductive semiconductor layer and the active layer to a portion of the first conductive semiconductor layer; and

a through electrode arranged inside the through hole,

wherein the through electrode extends from the first electrode, wherein the through electrode non-overlaps with the first current blocking layer in the vertical direction, and

wherein the first electrode overlaps the first current blocking layer in the vertical direction.

2. The light emitting device of claim **1**, further comprising an insulation layer arranged between the first electrode and the first current blocking layer and between the second electrode and the second current blocking layer.

3. The light emitting device of claim **2**, wherein the through hole is formed through the insulation layer.

4. The light emitting device of claim **1**, wherein the through electrode and the first current blocking layer are linearly arranged in a horizontal direction.

5. The light emitting device of claim **1**, wherein the insulation layer is arranged in the through hole to extend around the through electrode.

6. The light emitting device of claim **1**, wherein the first electrode comprises a first bonding pad and a first branched-finger electrode.

7. The light emitting device of claim **6**, wherein the first bonding pad is arranged at a first edge region of the light emitting device.

8. The light emitting device of claim **6**, wherein at least a portion of the first branched-finger electrode overlaps the through electrode and the first current blocking layer in the vertical direction.

9. The light emitting device of claim **1**, wherein the through electrode has a length smaller than a distance between neighboring through electrodes.

10. The light emitting device of claim **1**, wherein the second electrode comprises a second bonding pad and a second branched-finger electrode.

11. The light emitting device of claim **10**, wherein the second bonding pad is arranged at a second edge region of the light emitting device.

12. The light emitting device of claim **10**, wherein a portion of the second branched-finger electrode overlaps the second current blocking layer in the vertical direction.

13. The light emitting device of claim **1**, wherein a portion of the insulation layer is opened to form an open region, and the light-transmitting conductive layer is exposed through the open region.

14. The light emitting device of claim **13**, wherein the light-transmitting conductive layer and the second electrode are brought into direct contact at the open region.

15. The light emitting device of claim **13**, wherein the open region and the through electrode are alternately arranged in a horizontal direction.

16. The light emitting device of claim **1**, wherein at least one of the first current blocking layer and the second current blocking layer is a distributed Bragg reflector (DBR) or an omni-directional reflector (ODR).

17. A light emitting device comprising:

a light emitting structure comprising a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer;

a first current blocking layer and a second current blocking layer having a DBR or ODR structure and arranged on the light emitting structure to be separated from each other;

a light-transmitting conductive layer arranged on the first current blocking layer, the second current blocking layer and the light emitting structure and having the smallest thickness at regions corresponding respectively to the first current blocking layer and the second current blocking layer;

a first electrode and a second electrode electrically coupled to the first conductive semiconductor layer and the second conductive semiconductor layer, respectively;

a through hole formed through the light-transmitting conductive layer, the second conductive semiconductor layer, and the active layer to a portion of the first conductive semiconductor layer; and

a through electrode arranged in the through hole.

18. The light emitting device of claim **17**, wherein the first current blocking layer has a plurality of portions arranged spaced apart from each other.

19. The light emitting device of claim **18**, wherein the through hole is formed through the light-transmitting conductive layer, the second conductive semiconductor layer, and the active layer to a portion of the first conductive semiconductor layer, the light emitting device further comprises a through electrode arranged in the through hole, and a spacing between the portions constituting the first current blocking layer is the same as a length of the through hole.

20. A light emitting device comprising:

a light emitting structure comprising a first conductive semiconductor layer, an active layer, and a second conductive semiconductor layer arranged in a vertical direction;

a first current blocking layer and a second current blocking layer arranged on the light emitting structure to be separated from each other;

a light-transmitting conductive layer arranged on the first current blocking layer and the second current blocking layer and the light emitting structure;

a first electrode and a second electrode electrically coupled to the first semiconductor layer and the second conductive semiconductor layer, respectively; and

an insulation layer arranged between the first electrode and the first current blocking layer and between the second electrode and the second current blocking layer,

wherein a through hole is formed through the insulation layer, the light-transmitting conductive layer, the second conductive semiconductor layer, and the active layer to a portion of the first conductive semiconductor layer,

wherein the through hole does not overlap the first current blocking layer in the vertical direction,

wherein the first electrode overlaps the first current blocking layer in the vertical direction,

wherein a portion of the insulation layer is opened to form an open region, and the light-transmitting conductive layer is exposed through the open region, and

wherein the open region and the through hole are alternately arranged in a horizontal direction.

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